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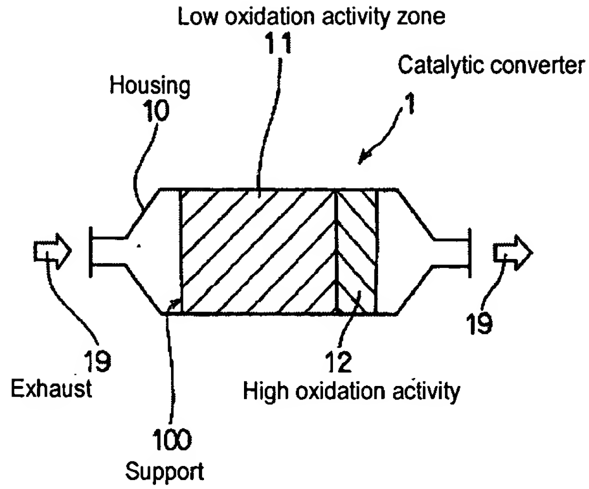
[Title of invention] Three-way exhaust cleaning method, catalytic converter, and process for production thereof

[Summary]

[Aim] The invention seeks to provide a three-way exhaust cleaning method of high cleaning rate and wide A/F window, a catalytic converter therefor and a process for the production thereof.

[Constitution] A low oxidation activity zone provided with a three-way catalyst for mainly NOx cleaning when the exhaust is at a leaner than theoretical air-fuel ratio is arranged upstream in the exhaust flow, a high oxidation activity zone provided with a three-way catalyst for NOx, CO and HC cleaning when the exhaust is at a richer than theoretical air-fuel ratio is arranged downstream therefrom, and the exhaust is passed sequentially between the two zones. The three-way catalyst in the low oxidation activity zone has a lower loading concentration of catalyst components than the catalyst in the high oxidation activity zone.



Scope of Claims

[Claim 1] A three-way exhaust cleaning method characterised as a three-way exhaust cleaning method for cleaning the exhaust gas discharged from engines by means of a three-way catalyst, wherein a low oxidation activity zone provided with a three-way catalyst for mainly NOx cleaning when the exhaust is at a leaner than theoretical air-fuel ratio is arranged upstream in the exhaust flow, a high oxidation activity zone provided with a three-way catalyst for NOx, CO and HC cleaning when the exhaust is at a richer than theoretical air-fuel ratio is arranged downstream therefrom, and the exhaust is passed sequentially between the two zones.

[Claim 2] A three-way exhaust cleaning method characterised in that the three-way catalyst in the aforesaid low oxidation activity zone in Claim 1 has a lower loading concentration of catalyst components than the three-way catalyst in the aforesaid high oxidation activity zone.

[Claim 3] A catalytic converter characterised as a catalytic converter wherein a three-way catalyst for cleaning exhaust gas discharged from engines is arranged inside a housing; wherein a low oxidation activity zone provided with a three-way catalyst for mainly NOx cleaning when the exhaust is at a leaner than theoretical air-fuel ratio is arranged upstream in the exhaust flow while a high oxidation activity zone provided with a three-way catalyst for NOx, CO and HC cleaning when the exhaust is at a richer than theoretical air-fuel ratio is arranged downstream therefrom.

[Claim 4] A catalytic converter characterised in that the three-way catalyst in the aforesaid low oxidation activity zone in Claim 3 has a lower loading concentration of catalyst components than the three-way catalyst in the aforesaid high oxidation activity zone.

[Claim 5] A catalytic converter characterised in that catalyst components in the aforesaid three-way catalyst in Claim 3 or 4 comprise at least one component chosen from the group rhodium, platinum or palladium and the loading concentration of catalyst components in the low oxidation activity zone with respect to the support is between 0.001 g/litre and 0.5 g/litre.

[Claim 6] A catalytic converter characterised in that in any of Claims 3 to 5 the volume of the aforesaid low oxidation activity zone is 1-20 times the volume of the high oxidation activity zone.

[Claim 7] A process for the production of a catalytic converter characterised as a process for producing a catalytic converter for cleaning the exhaust gas discharged from engines that possesses a housing wherein a low oxidation activity zone provided with a three-way catalyst for mainly NOx cleaning when the exhaust is at a leaner than theoretical air-fuel ratio is arranged upstream in the exhaust flow while a high oxidation activity zone provided with a three-way catalyst for NOx, CO and HC cleaning when the exhaust is at a richer than theoretical air-fuel ratio is arranged downstream therefrom; wherein the aforesaid low oxidation activity zone is previously subjected to low activation treatment at a temperature of 700°C-1200°C in an oxidising atmosphere of oxygen concentration 0.05%-5%.

[Claim 8] A process for the production of a catalytic converter characterised in that the three-way catalyst of the aforesaid low oxidation activity zone in Claim 7 has a lower loading concentration of catalyst components than the three-way catalyst in the aforesaid high oxidation activity zone.

Detailed Description of Invention

[0001]
[Field of industrial utility] The invention relates to a three-way cleaning method for cleaning the NOx, CO and HC in exhaust gas discharged from engines, for example spark ignition engines, compression ignition engines or Stirling engines, and to the catalytic converter used in this cleaning method and a process for production thereof.

[0002]
[Prior art] “Three-way exhaust cleaning” whereby CO, HC and NOx are cleaned up in a single catalytic converter has heretofore been practised in cleaning exhaust gas from automotive engines, etc. Heretofore used as the catalytic converter in the aforesaid three-way exhaust cleaning is a catalytic converter wherein a three-way catalyst comprising three-way catalyst components such as platinum (Pt), platinum-rhodium (Pt-Rh) and palladium (Pd) loaded onto a support is accommodated in a housing.

[0003] Simultaneous cleaning of CO, HC and NOx from exhaust gas with the aforesaid three-way catalyst is conducted with the greatest efficiency when the "air-fuel ratio" (hereunder denoted A/F) is equal to the theoretical air-fuel ratio (A/F = 14.7 in the case of petrol). As shown in Fig.4, the "air excess factor" (hereunder denoted λ) at the theoretical air-fuel ratio is equal to 1.

[0004] The percentage CO and HC clean-up deteriorates in the rich region where the aforesaid λ is equal to or less than 1, or A/F is at or below the theoretical air-fuel ratio ($\lambda \leq 1$, A/F$\leq$14.7). On the other hand, the percentage NOx clean-up deteriorates markedly in the lean region where the aforesaid λ is greater than 1 and A/F is greater than the theoretical air-fuel ratio ($\lambda > 1$, A/F>14.7). For three-way exhaust cleaning to be implemented, therefore, engine combustion must discharge exhaust wherein λ and A/F are held within a specified range close to the theoretical air-fuel ratio at all times. The air and fuel mixing ratio, etc, in the engine must therefore be suitably controlled. In general, the "A/F window" is adopted as the aforesaid specified range.

[0005] The aforesaid A/F window represents the interval demarcated by the "point at which $\lambda=1$, that is, A/F equals the theoretical air-fuel ratio" and the "point at lean ratio at which NOx clean-up reaches 60%" shown in Fig.4. The width of the A/F window is expressed by $\Delta\lambda$, the difference on subtracting 1 from the value of λ at which the percentage NOx clean-up reaches 60% at lean ratio. For example, the width of the A/F window for the three-way catalyst shown in Fig.4 is $\Delta\lambda=0.004$.

[0006] It is also known that the loading of the three-way catalyst in the catalytic converter may be increased in order to raise exhaust cleaning efficacy in the aforesaid method of three-way exhaust cleaning.

[0007]

[Problem to be solved] However, increasing the amount of catalyst in the catalytic converter creates the following problem. Thus, the relation between λ and percentage clean-up of NOx, CO and HC at the theoretical air-fuel ratio in the catalytic converter is altered by an increase in catalyst loading: although the percentage clean-up increases at $\lambda=1$, i.e. at the theoretical air-fuel ratio, the percentage NOx clean-up at leaner ratio is reduced. The A/F window therefore becomes narrower. More precise A/F control hence becomes necessary, with the attendant possibility of raising the cost, etc, of the engine or its operating control system.

[0008] In view of this problem, the invention seeks to provide a three-way exhaust cleaning method of high cleaning rate and wide A/F window, a catalytic converter therefor and a process for the production thereof.

[0009]

[Means of solving the problem] The invention resides in a three-way exhaust cleaning method characterised as a three-way exhaust cleaning method for cleaning the exhaust gas discharged from engines by means of a three-way catalyst; wherein a low oxidation activity zone provided with a three-way catalyst for mainly NOx cleaning when the exhaust is at a leaner than theoretical air-fuel ratio is arranged upstream in the exhaust flow while a high oxidation activity zone provided with a three-way catalyst for NOx, CO and HC cleaning when the exhaust is at a richer than theoretical air-fuel ratio is arranged downstream therefrom and the exhaust is passed sequentially between the two zones.

[0010] The most notable feature of the invention is that the aforesaid low oxidation activity zone is arranged upstream while the aforesaid high oxidation activity zone is arranged downstream in the exhaust flow.

[0011] The aforesaid low oxidation activity zone is placed in a state of low oxidation activity whereby, as described hereunder, oxidation of HC and CO is suppressed when the exhaust is at lean ratio. To maintain the aforementioned state, the concentration at which the catalyst components are loaded onto the support is reduced in the aforesaid low oxidation activity zone as compared with the three-way catalyst of the high oxidation activity zone. The aforesaid high oxidation activity zone is placed in the same state of oxidation activity as a conventional three-way catalyst; and the catalyst loading concentration therein is the same as for a conventional catalytic converter.

[0012] The constitution of the catalytic converter whereby the aforementioned three-way exhaust cleaning is attained will now be described. Thus, the catalytic converter is characterised as a catalytic converter wherein a three-way catalyst for cleaning the exhaust gas discharged from an engine is arranged inside a housing, wherein a low oxidation activity zone provided with a three-way catalyst for mainly NOx cleaning when the exhaust is at a leaner than theoretical air-fuel ratio is arranged upstream in the exhaust flow while a high oxidation activity zone provided with a three-way catalyst for NOx, CO and HC cleaning when the exhaust is at a richer than theoretical air-fuel ratio is arranged downstream.

[0013] In addition, the three-way catalyst in the aforesaid low oxidation activity zone has a lower loading concentration of catalyst components than the three-way catalyst in the aforesaid high oxidation activity zone.

[0014] The aforesaid low oxidation activity zone is provided in a part of the three-way catalyst support upstream in the exhaust flow. As described hereunder, the loading concentration of catalyst components per unit volume of the support is lower in the low oxidation activity zone and the said catalyst components are subjected to low oxidation activity treatment beforehand.

[0015] The high oxidation activity zone lies downstream in the exhaust flow adjacent to the aforesaid low oxidation activity zone, and the catalyst concentration therein is essentially the same as the catalyst concentration in a conventional catalytic converter. The aforesaid low oxidation activity zone and high oxidation activity zone can be provided in the same support. They can also be provided in different supports, which can be arranged sequentially in the housing.

[0016] The catalyst components of the aforesaid three-way catalyst are preferably one or more components chosen from the group rhodium, platinum or palladium and the loading concentration of catalyst components with respect to the support in the low oxidation activity zone is preferably between 0.001 g/litre and 0.5 g/litre. When platinum is used as the catalyst component, a suitable amount of rhodium can be added thereto.

[0017] The aforesaid loading concentration is the weight of catalyst components supported per unit volume of support (g/litre). The loading concentration of catalyst components in the aforesaid low oxidation activity zone is preferably not less than 0.001 g/litre. When the said concentration is less than 0.001 g/litre, the number of sites active in NOx cleaning diminishes and there is therefore a possibility that the percentage NOx clean-up will actually decrease. Moreover, the effect of decline in activity due to accumulation of ash content in the exhaust during exhaust clean-up is then relatively greater; and since marked deterioration arises, stable performance is no longer obtained.

[0018] When the aforesaid loading concentration exceeds 0.5 g/litre, on the other hand, the oxidation activity of the catalyst increases and the quantity of heat evolved per unit volume increases. There is therefore a possibility that the percentage NOx clean-up will decrease. Moreover, a more preferable lower limit on loading concentration is 0.03 g/litre.

[0019] Contrary to the requirement in the low oxidation activity zone, a higher loading concentration of catalyst components is to be preferred in the aforesaid high oxidation activity zone. If the catalyst component is platinum, the loading concentration is preferably 2-5 g/litre. If the component is palladium, the loading concentration is preferably 2-20 g/litre.

[0020] Since the exhaust cleaning rate is saturable, loading with more catalyst component than the upper limit of the aforesaid range could produce a surfeit of catalyst that contributes nothing to exhaust cleaning. Again, the function of the high oxidation activity zone could decline if the loading concentration is below the lower limit of the aforesaid range.

[0021] The volume of the aforesaid low oxidation activity zone is preferably 1-20 times that of the high oxidation activity zone. If the volume of the aforesaid low oxidation activity zone is less than once that of the high oxidation activity zone, there is a possibility the exhaust will

effuse to the high oxidation activity zone before NOx cleaning is complete. There is then a risk that the percentage NOx clean-up will decrease when the exhaust is lean, and the A/F window will narrow.

[0022] Again, should the volume of the low oxidation activity zone be more than 20 times that of the high oxidation activity zone, NOx cleaning will be essentially complete part way through the low oxidation activity zone. There will accordingly be no increase in NOx cleaning efficiency. The upper limit on the volume of the low oxidation activity zone is more preferably set at no more than 10 times the volume of the high oxidation activity zone.

[0023] Moreover, NOx cleaning at lean ratio takes time, and the path length of the exhaust flow in the low oxidation activity zone must therefore be long enough for NOx cleaning of the exhaust gas in transit to reach completion. On the other hand, since NOx cleaning and CO and HC cleaning are completed in a short time at rich ratio, a short zone of high oxidation activity is permissible.

[0024] For instance, the length of the low oxidation activity zone is preferably set at between 5 cm and 50 cm for the catalytic converter fitted to ordinary vehicles; wherein, more preferably, the upper limit is 30 cm and the lower limit is 10 cm. The length of the high oxidation activity zone, on the other hand, is preferably set at between 0.5 cm and 10 cm; wherein, more preferably, the upper limit is 5 cm and the lower limit is 1 cm. Thus, there is no point in lengthening the zones beyond the respective aforesaid upper limits since exhaust cleaning will then reach completion part way through the respective zones. On the other hand, exhaust cleaning may not reach completion if the zones are shorter than the aforesaid lower limits.

[0025] As to production of the aforesaid catalytic converter, the invention provides a process for the production of a catalytic converter for cleaning the exhaust gas discharged from engines characterised as a process for the production of a catalytic converter that possesses a housing wherein a low oxidation activity zone provided with a three-way catalyst for mainly NOx cleaning when the exhaust is at a leaner than theoretical air-fuel ratio is arranged upstream in the exhaust flow while a high oxidation activity zone provided with a three-way catalyst for NOx, CO and HC cleaning when the exhaust is at a richer than theoretical air-fuel ratio is arranged downstream therefrom; wherein the aforesaid low oxidation activity zone is previously subjected to low activation treatment at a temperature of 700°C-1200°C in an oxidising atmosphere of oxygen concentration 0.05%-5%.

[0026] It is important that the high oxidation activity zone is installed after the low oxidation activity zone has been given low activation treatment as hereinbefore stated. Thus, the purpose of the aforesaid low oxidation activity treatment is to prevent deterioration due to

particle aggregation in service and to smooth heat transfer from the three-way catalyst to the support by ensuring the three-way catalyst has a uniform particle size and is properly dispersed on the support. The aforesaid treatment should not therefore be applied to both zones. In addition, the three-way catalyst in the aforesaid low oxidation activity zone preferably has a lower loading concentration of catalyst components than the three-way catalyst of the aforesaid high oxidation activity zone.

[0027] When the oxygen concentration in the aforesaid low activation treatment is less than 0.05%, the time required for low activation treatment is lengthened, or else the desired low oxidation activity zone cannot be obtained unless the temperature of the low activation treatment is set at a high temperature of say 1300°C; in which case the alumina supporting the three-way catalyst undergoes transformation and the three-way catalyst thereon supported undergoes aggregation because the specific surface area is much reduced. When rhodium is used as the three-way catalyst, moreover, the rhodium reacts with the alumina and is inactivated. It may therefore be impossible to strike a balance between oxidation activity and NOx cleaning activity.

[0028] If the oxygen concentration is greater than 5%, on the other hand, the catalyst components in the catalyst aggregate unevenly; in which case the percentage NOx clean-up may decline. A more preferred range of the aforesaid oxygen concentration has the upper limit at 3% and the lower limit at 0.1%.

[0029] If the temperature of the aforesaid low activation treatment is less than 700°C, low oxidation activity is not obtained and it is hence possible that NOx cleaning capability at lean ratio will be deficient. If the temperature exceeds 1200°C, on the other hand, it is possible that the alumina constituting the support will undergo transformation.

[0030] The duration of the aforesaid low activation treatment is preferably between 1 hour and 10 hours. If the aforesaid treatment time is less than 1 hour, the same problems can arise as when the treatment temperature is less than 700°C. If the treatment time is more than 10 hours, on the other hand, the production cost rises, making the process impractical. The aforesaid low activation treatment of the low oxidation activity zone is conducted either after or before insertion of the said zone in the housing.

[0031]
[Action and effect] The three-way exhaust cleaning method claimed for the invention cleans the exhaust by arranging a low oxidation activity zone upstream in the exhaust flow, arranging a high oxidation activity zone downstream thereof, and passing the exhaust gas sequentially between the two zones.

[0032] The exhaust is first admitted to the aforesaid low oxidation activity zone. The low oxidation activity zone is intended mainly for NOx cleaning and supports a low oxidation activity catalyst that suppresses oxidation of CO and HC. NOx cleaning is therefore achieved by the aforesaid catalyst when the exhaust is lean.

[0033] Thus, at the aforesaid lean ratio, oxygen is present in abundance: CO and HC oxidation, and NOx reduction by CO and HC therefore proceed in parallel. Since the aforesaid oxidation reactions are suppressed in the aforesaid low oxidation activity zone, reduction of NOx by CO and HC cannot be activated. Hence, NOx cleaning proceeds with high efficiency in the aforesaid low oxidation activity zone when the exhaust is lean.

[0034] After passing through the low oxidation activity zone, the exhaust is admitted to the high oxidation activity zone. A conventional three-way catalyst is supported in the aforesaid high oxidation activity zone. When the aforesaid exhaust is at a rich ratio, therefore, cleaning of NOx and cleaning of CO and HC, which eluded cleaning in the low oxidation activity zone, can be achieved to the same level as heretofore. For reference, Fig.3 shows the characteristics of three-way catalyst of low activity that has been treated to suppress the aforesaid oxidation.

[0035] According to Fig.3, the percentage NOx clean-up at lean ratio is greatly improved above that of a conventional catalyst; the A/F window hence broadens to $\Delta\lambda=0.021$. However, since the percentage clean-up of CO and HC at rich ratio greatly deteriorates, it is undesirable simply to replace a conventional three-way catalyst with a three-way catalyst of low oxidation activity.

[0036] As hereinbefore noted, the aforementioned catalyst of low oxidation activity is arranged in the low oxidation activity zone in the invention and has the role of cleaning NOx at lean ratio and widening the A/F window. At the same time, a high oxidation activity zone holding a conventional catalyst is arranged downstream from the aforesaid low oxidation activity zone in the exhaust flow and has the role of cleaning CO and HC, and NOx at rich ratio. Three-way exhaust cleaning of high cleaning rate hence becomes possible in both lean and rich exhaust flows.

[0037] In addition, and for the same reasons, the catalytic converter of the invention is capable of three-way exhaust cleaning of high cleaning rate and has a wide A/F window. Moreover, an outstanding catalytic converter as hereinbefore described can be obtained by the production process of the invention.

[0038] The invention thus affords a three-way exhaust gas cleaning method of high cleaning rate and wide A/F window, a catalytic converter therefor and a process for production thereof.

[0039]
[Working examples]

Working Example 1

The three-way exhaust gas cleaning method in the working examples of the invention and the catalytic converter used therein will be described with the aid of Fig.1 and Fig.2. The catalytic converter in this example is a converter for fitting to a motor vehicle with an engine cylinder capacity of 1.8 litre.

[0040] As shown in Fig.1, the catalytic converter 1 in Working Example 1 has a three-way catalyst arranged in a housing 10 for cleaning the exhaust 19 discharged from the engine. Arranged at the exhaust upstream end is a low oxidation activity zone 11 provided with a three-way catalyst for cleaning mainly NOx when the exhaust 19 is leaner than at the theoretical air-fuel ratio.

[0041] Arranged at the downstream end is a high oxidation activity zone 12 provided with a three-way catalyst for cleaning the CO and HC remaining in exhaust that has passed through the low oxidation activity zone and for cleaning NOx, CO and HC when the exhaust 19 is at a rich ratio, below the theoretical air-fuel ratio.

[0042] The volume of the support 100 supporting the three-way catalyst in the aforesaid catalytic converter 1 is 1.3 litre. The low oxidation activity zone 11 corresponds to the upstream 4/5 of total support volume of the aforesaid support 100. The high oxidation activity zone 12 corresponds to the downstream 1/5 of the aforesaid support.

[0043] The catalyst components of the aforesaid three-way catalyst are platinum and rhodium. The loading concentrations of the catalyst components in the low oxidation activity zone 11 with respect to the catalyst support are platinum 0.2 g/litre and rhodium 0.04 g/litre. Moreover, the catalyst components in this zone have been subjected to low oxidation activity treatment as shown in Working Example 2 hereunder. The loading concentrations of the catalyst components in the aforesaid high oxidation activity zone 12 are platinum 2 g/litre and rhodium 0.4 g/litre.

[0044] The action and effect in this example will now be explained. To clean the exhaust 19 with the catalytic converter 1 of the example, exhaust 19 is first admitted to the aforesaid low oxidation activity zone 11. The low oxidation activity zone 11 is intended mainly for the clean-up of NOx and supports a low oxidation activity catalyst that suppresses oxidation of CO and HC. The aforesaid catalyst therefore accomplishes cleaning of NOx when the exhaust is at lean ratio.

[0045] Thus, under the aforesaid lean conditions, a large amount of oxygen is present: oxidation of CO and HC, and the reduction of NOx by CO and HC will hence occur in parallel. In the aforesaid low oxidation activity zone 11, however, the aforesaid oxidation is suppressed and more active reduction of NOx by CO and HC can therefore be achieved. Hence, NOx cleaning is performed with high efficiency in the aforesaid low oxidation activity zone 11 when the exhaust 19 is at a lean ratio.

[0046] After passage through the low oxidation activity zone 11, the exhaust 19 is admitted to the high oxidation activity zone 12. Supported in the aforesaid high oxidation activity zone 12 is a conventional three-way catalyst. When the aforesaid exhaust is at a rich ratio, therefore, cleaning of the NOx and CO and HC that escaped cleaning in the low oxidation activity zone 11 can be accomplished at the same level as heretofore.

[0047] Fig.2 shows the cleaning rate characteristic of the catalytic converter 1 of Working Example 1 for exhaust at a temperature of 300°C. It will be seen from the diagram that the percentage NOx clean-up greatly improves when the exhaust is at lean ratio on account of the low oxidation activity zone 11; and by virtue of the high oxidation activity zone 12, the percentage clean-up of NOx and CO/HC when the exhaust is at rich ratio is greater than for low oxidation activity catalyst (*c.f.* Fig.3), assuring the same level of cleaning as with a conventional three-way catalyst.

[0048] Furthermore, since the percentage NOx clean-up when the exhaust is at lean ratio is greatly improved, the breadth of the A/F window, *viz.* $\Delta\lambda$=0.033, is increased almost ten-fold compared with a conventional three-way catalyst (*c.f.* Fig.4). Accordingly, the example affords a three-way exhaust cleaning method of high cleaning rate and wide A/F window, a catalytic converter therefor and a process for the production thereof.

[0049] Again, a conventional catalytic converter has a platinum loading concentration of around 1.0 g/litre and a rhodium loading concentration of around 0.2 g/litre. The catalyst loading in a converter of the same size as in this example is hence platinum 1.3 g and rhodium 0.26 g. The total catalyst loading in the catalytic converter of the example is as follows.

[0050] Platinum

Low oxidation activity zone: 1.3 litre × (4/5) × 0.2 g/litre = 0.208 g

High oxidation activity zone: 1.3 litre × (1/5) × 2 g/litre = 0.52 g

Total Pt loading: 0.208 g + 0.52 g = 0.728 g

[0051] Rhodium

Low oxidation activity zone: 1.3 litre × (4/5) × 0.04 g/litre = 0.0416 g

High oxidation activity zone: 1.3 litre × (1/5) × 0.4 g/litre = 0.104 g
Total Rh loading: 0.0416 g + 0.104 g = 0.145 g

[0052] The catalyst loading in the catalytic converter 1 of the example has accordingly been reduced to 56% of that of a conventional catalytic converter, making the converter inexpensive to produce.

[0053] Incidentally, when HC of momentarily high concentration enters a catalytic converter from the engine, all the HC may be oxidised at the same time, generating a large amount of heat. The aforesaid large amount of heat has been a primary cause of the thermal degradation of catalyst support and catalysts.

[0054] A low oxidation activity zone 11 has been provided upstream in the exhaust flow in the catalytic converter 1 of this example. The aforesaid low oxidation activity zone 11 has low oxidation activity and has been subjected to low oxidation activity treatment. Notwithstanding influx of a large amount of HC, therefore, no great amount of heat is evolved; accordingly, thermal degradation of the support 100 does not occur. The catalytic converter 1 of the example hence has a long service life.

[0055] *Working Example 2*

This example explains the process for production of the catalytic converter in Working Example 1. Firstly, a three-way catalyst of platinum and rhodium for the low oxidation activity zone is loaded on a support. The aforesaid loading concentrations are platinum 0.2 g/litre and rhodium 0.04 g/litre. The aforesaid low oxidation activity zone is provided on 4/5 of the total volume of the support.

[0056] Low activation treatment is then applied to the aforesaid low oxidation activity zone. The aforesaid low activation treatment is conducted for 5 hours in a non-oxidising atmosphere comprising oxygen 0.3% and nitrogen 99.7%, with the temperature set at 850°C. A low oxidation activity zone of depressed oxidation activity is thereby obtained. The three-way catalyst for the high oxidation activity zone is then loaded to the remaining 1/5 of the support. The loading concentrations in the aforesaid three-way catalyst are platinum 2 g/litre and rhodium 0.4 g/litre.

[0057] Thereafter the support provided with the aforesaid zones is arranged inside a housing to provide a catalytic converter. In other respects the example is the same as Working Example 1. The catalytic converter of the example has a low oxidation activity zone formed by the aforesaid low activation treatment and is thus able to provide an outstanding catalytic converter of wider A/F window. In other respects it has the same action and effect as Working Example 1.

[0058] The aforesaid low oxidation activity treatment must be applied when the catalytic converter is being produced; it may not be carried out in actual exhaust gas. Thus, it is impossible to form a low oxidation activity zone in exhaust gas since the oxygen concentration cannot be accurately controlled. Furthermore, active species other than oxygen, such as CO, HC and H_2O are present in exhaust gas. Moreover, a catalytic converter rises in temperature locally in response to reaction of these active species. This makes it impossible to achieve a uniform effect in depressing oxidation activity in the low oxidation activity zone.

Brief Description of Drawings

[Fig.1] A diagram of the catalytic converter in Working Example 1.
[Fig.2] A graph showing the relation between the air excess and percentage NOx, CO and HC clean-up for the catalytic converter in Working Example 1.
[Fig.3] A graph showing the relation between air excess and percentage NOx, CO and HC clean-up in a three-way catalyst of low oxidation activity.
[Fig.4] A graph showing the relation between air excess and percentage NOx, CO and HC clean-up in a conventional three-way catalyst.

[Key]
1... catalytic converter
10... housing
100... support
11... low oxidation activity zone
12... high oxidation activity zone
19... exhaust

Fig.1

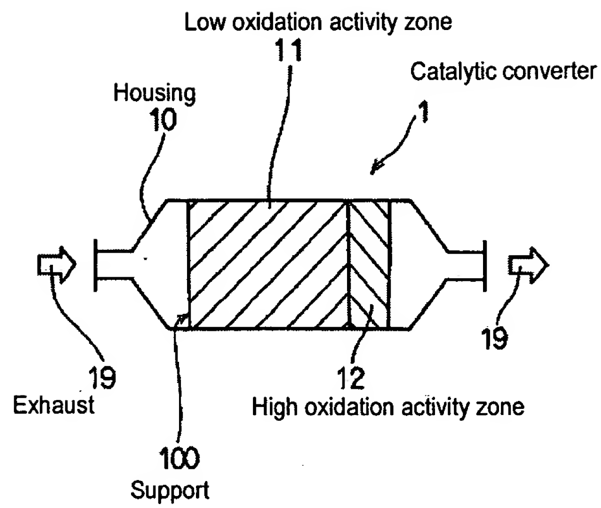


Fig.2

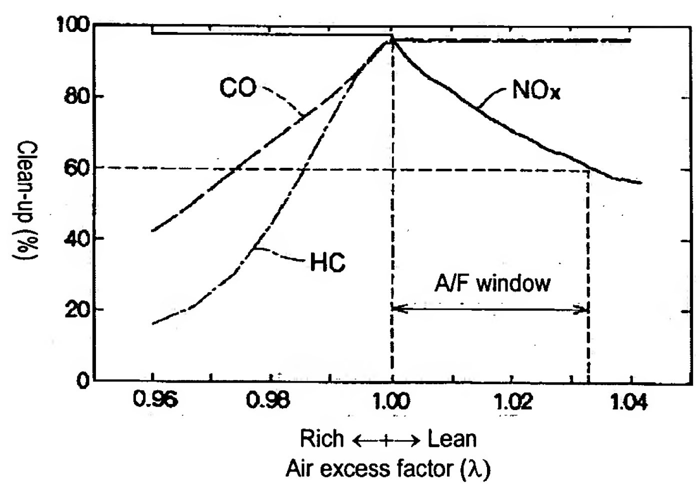


Fig.3

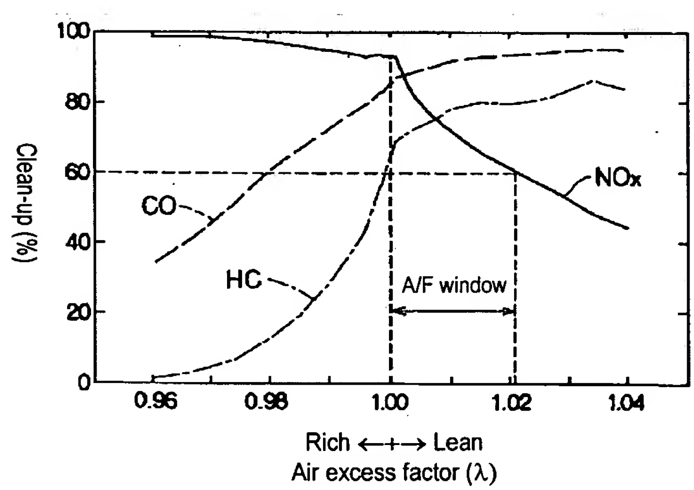
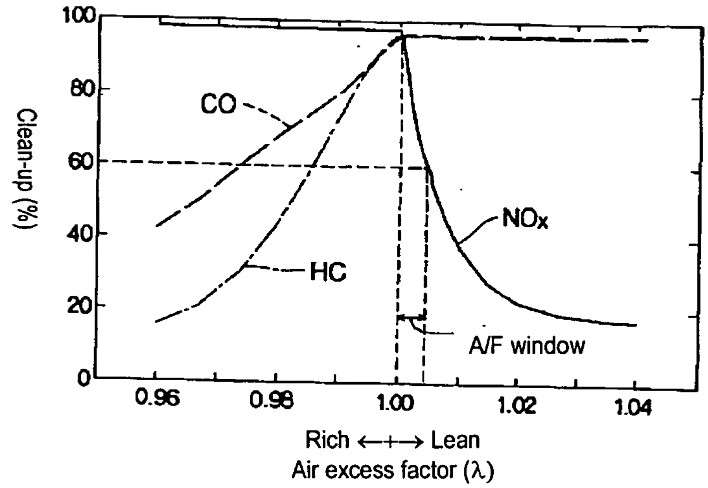


Fig.4



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